SARC 45 – Assessments of Gulf of Maine Northern Shrimp and Atlantic Sea Scallop

CIE Reviewer's Report

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Information Used

Dr. J. Weinberg, NMFS, Woods Hole, arranged for all background documents, including past assessments of both stocks and materials prepared for the present assessment, to be placed on a dedicated website. All documents on that site were downloaded and read. In addition, references on the two key assessment models – CSA for Northern Shrimp and CASA for Atlantic Sea Scallop – were consulted for details of those analytical methods. SARC 45 was conducted from June 4-9, 2007, chaired by Dr. Mike Prager.

Presentations were made by the Northern Scallop team on June 4, and the Atlantic Sea Scallop team on June 5. Questions and discussion during and following the presentations led to requests to both teams for additional information. The additional material was presented and discussed on June 6. The assessment reports prepared by the two assessment teams were also reviewed with the teams, and the reviewers and NMFS staff provided suggestions for revisions to the two documents. The remainder of the review period was spent in preparing the SARC 45 Summary Document (Dr. Prager as drafter of the document) and starting the independent reports by the three CIE reviewers, J.-J. Maguire, N. Caputi, and myself. I was assigned to be lead reviewer for the Northern Shrimp, and in the following commentary, my observations on that assessment are somewhat more detailed than on the Atlantic Sea Scallop.

The SARC 45 Summary Document is a consensus document, and I support fully all its conclusions and recommendations. In several places in this review I refer to that report as a source of information on strengths and weaknesses in the data and analyses on which the conclusions about stock status and advice on management are based, rather than repeating the information here. Both assessments were very well done, and the presentations professional and informative, notwithstanding the lengthy discussion of opportunities to improve the assessments and data on which they are based. I thank both assessment teams for their excellent and interesting work and patience with our questioning, Dr. Weinberg for excellent preparations and support during the meeting, Dr. Prager for excellent conduct of the review, and all the participants, particularly the other CIE reviewers and assessment leads, for a number of insights into invertebrate fisheries.

Commentary on the Northern Shrimp Assessment

I: Was each Term of Reference completed successfully and do the results provide a sound scientific basis for management advice?

1. Characterise the Gulf of Maine northern shrimp commercial fishery.

This term of reference was completed successfully. The core assessment report contained fairly complete information on catch, effort, landings, and discards. More complete information could be provided on the development of the fleet over time, because LPUE is used as an index of stock status in the analytical assessment. There also seems to be a great deal of latent effort in this fishery (vessels that may participate in the shrimp fishery in some years/seasons, and may not participate in others, for reasons that have little to do with the status of the resource or the provisions of the management plan). This latent effort is relevant to managing the fishery, particularly because stock status can fluctuate greatly due to recruitment variation, and might be discussed a bit more thoroughly in the assessment.

The major shortcoming in the information on fishery operations was a low rate of biological sampling of catches from the fishery. Not only was the sampling rate low, but samples were almost certainly clustered in space and time. That is, allocation of sampling effort did not appear to follow an overall experimental design with formal stratification by month, port, gear sector, and other factor. Rather it was likely that port samplers would visit a coastal community where shrimp were being landed, spend a few days sampling catches from vessels landing in that community, and then move on to another community. Particularly with a low overall sampling effort, such cluster sampling has the potential to introduce some bias into the data on biological characteristics of the catches; bias that would be carried into the analyses of the assessment.

Although this is an imperfect situation, there was no evidence from the sampling data of significant problems with major bias due to cluster sampling. Moreover it is acknowledged that sampling strategies with ideal statistical design would be much less efficient with the time and travel costs of the port samplers. With no obvious evidence of significant bias in the existing data stream, it would be hard to justify greatly reducing the practical (as contrasted with statistical) efficiency of collecting catch samples just to reduce a possible (but not certain) and likely small bias. Rather, it would be much more desirable to increase the overall investment in collection of samples, and take what practical measures as could be done to allocate the sampling effort to be as representative as possible of the distribution of catches by area, gear sectors, and time.

There are statistical methods available to test for the presence of bias due to cluster sampling, and these might be applied to the sampling data to determine if and how large the current bias is. However, such analyses would be much lower priority than some of the other analyses to be discussed later. The more important step is to increase sampling of the fishery.

2. Estimate fishing mortality and exploitable stock biomass, characterise uncertainty in the estimates, and provide estimates for earlier years.

This Term of Reference was completed successfully. The results reported in the SARC Summary Report are a scientifically sound basis for management of the fishery. The CSA model was the primary analytical tool used in the assessment, and it was considered to be an appropriate method for the commercial and research survey information that is available and species with the life histories of *Pandalus*. The other analytical methods used, particularly ASPIC, were useful in providing additional information on stock status and trends, but I (and the reviewers in general) agreed with the assessment team that CSA was the best of the methods applied to the stock. Sensitivity analyses supported a conclusion that the trends in the analytical results were robust, and confidence intervals for the annual estimates were tight (aside from the most recent two years – to be addressed below). The ASPIC and CSA results were generally consistent, with the minor differences in trends in F and B readily explained by differences in how the two models used the information available. The goodness of fit information, including residual patterns, were good by usual assessment standards, with the CSA results having less autocorrelation in the residuals than did the ASPIC results.

Although the CSA model was considered appropriate for the life history of *Pandalus* shrimp, and the data available and results are a scientifically sound basis for management advice, three points require attention. First of all, CSA assumes no process error, when in reality there are several biological processes that are not captured dynamically in the population dynamics equations, and some fishery characteristics that are also treated as if they were constant, whereas they almost certainly vary dynamically with the state of the resource, the status of other species also exploited in the area, and markets. Two important ecological processes not represented accurately in the assessment model at present are natural mortality – particularly mortality due to predation – and the effects of temperature on stock productivity and distribution. M is treated as a constant in the model, although there is growing evidence that predator consumption of shrimp has varied greatly over past decades. The implications of this point are developed more fully in the comments on ToR 6, where there are suggestions for addressing the implications as well.

The assessment report discusses the importance of temperature to shrimp distribution and year class strengths in several places, as well as some of the implications of the temperature-distribution relationships for fishery performance. Nonetheless, the analytical models do not consider forcing due to temperature when using survey data, catch rate information, or tracking recruitment and growth dynamics. The Review Panel requested and received an update on biological information about past research into the temperature – productivity relationships, and the excellent update provided a basis for discussion of several lines of inquiry into more process-based insights and models regarding the role of temperature in stock dynamics. I am satisfied that the assessment team and their scientific colleagues have good ideas of where to go with these investigations, but the work has been a secondary priority for all the experts, such that

progress has been slow and sporadic. I would encourage the priority given to this work be raised, particularly in light of the apparently unprecedented increase in recruitment to this stock. As results become available, they could be incorporated directly into the CSA models through many possible combinations of revised population equations within the model and revisions to the survey and catch rate data sets to which the model is fit.

The second point requiring attention is that presently there is no spatial component to the treatment of any of the data sources. Both temperature and depth were noted in the assessment document and presentations to affect distribution strongly and there is a strong seasonal migration pattern in the stock. Moreover, the fishery was reported to respond to these spatial dynamics as well. There are both data-based and model-based methods for capturing these spatial patterns analytically, and either improving the CPUE and survey indices as inputs to CSA and ASPIC, or adding some spatial structure to the assessment model itself. The latter option is much more demanding than the former, and may not be justified – at least until there is confidence that the spatial information will improve the accuracy or robustness of the assessment. However, some of the GAM and kernel-based approaches to including spatial pattern in analyses of survey data might be easy to apply for the survey data (and possibly the CPUE data, if the fishery information is geo-referenced), and provide survey indices with additional information as inputs to the CSA. These have been applied in other northern shrimp stocks (See Evans, Parsons and Veitch, Journal of Northwest Atlantic Fisheries Science (2000) 17; 133-138) with a substantial payoff. Because of the strong spatial information in the survey data, this work should be a priority.

The third, and most important, consideration needing attention is the apparently unprecedented increase in recruitment to this population. The significance of the exceptional 2004 year-class to stock status and fisheries in 2007 is treated adequately in the assessment and the concerns of the reviewers are captured well in the SARC 45 Summary Report. I support fully the comments in that report, and agree that even though there is substantial uncertainty about the accuracy and precision of the estimate of that year-class, the current scientific advice can be the basis for management that poses low risk to the stock. Nonetheless, it is important that extra effort be taken in 2007 to ensure that scientific advice for 2008 can be equally robust. This includes establishing the survivorship of this yearclass to the extent possible through surveys and catch monitoring, and getting as accurate a direct estimate as possible of its biomass, possibly through more spatially based analyses of 2007 surveys.

The exceptional yearclass also provides an opportunity to test a variety of scientific hypotheses. This yearclass might yield substantial information about the influence of environmental conditions on recruitment dynamics and habitat preferences affecting spatial distribution. Studies of predator behaviour and diets in this year might also yield a great deal of information about functional feeding patterns of predators, carrying capacity of the Gulf of Maine for shrimp, and the role of density dependent processes in shrimp population dynamics. Shrimp have a key role in the food web for the Gulf of Maine, and predators have a major role in shrimp population dynamics (notwithstanding the use of M=0.25 in the assessment and biological reference points). Nature has provided an

opportunity to study these roles under conditions of exceptional (possibly extreme) shrimp abundance, and the opportunity should not be missed. The type of trophodynamic studies that were presented to the review panel are quite appropriate to continue to pursue – the important message from the reviewer is that 2007 will be a year to make especially intense efforts at data collection and analyses.

3. Comment on the scientific adequacy of the biological reference points.

The SARC 45 Summary Report contains a thorough treatment of the views of the Review Panel on the biological reference points. Under present circumstances the biological reference points are an adequate basis for management. They provide adequate protection of the stock from risk of overfishing or stock depletion, and they are not likely to constrain the fishery unnecessarily under present biomass and market conditions. Nonetheless several shortcomings were found with the biological reference points, and these should be addressed before the stock returns to a biomass where the reference points are likely to play a role in constraining harvesting opportunities. Several of these shortcomings and suggested analyses are reported in the SARC 45 Summary Report, but additional points can be made. The stock recruitment information (figure provided at the meeting) shows that at any given SSB a wide range of recruitments are possible, but nonetheless there is a significant increase in likelihood of poor recruitment at low SSB. Probabilistic alternatives to parameterized Ricker or B-H models are available (see, for example, Shelton and Morgan - Journal of Northwest Atlantic Fisheries Science (2005) 36:147-153; Rice and Evans ICES Journal of Marine Science (1988) 45; 73-81) and would be particularly appropriate for determining the SSBs at which the likelihood of poor yearclasses increased. Such information would be a useful addition to the work on natural mortality that is recommended in the SARC 45 Summary Report, when selecting an ecologically appropriate biomass reference point.

The exceptional 2004 yearclass also has implications for revisions to F reference points. The conservation benefits of any F limit constraining catches from exceptional (but short-lived - given any reasonable value of natural mortality for a species with a life expectancy of about six years) year-classes can be hard to demonstrate. Under present conditions the F limit will not be an issue for managing the shrimp fishery, so there is no urgency to digging into how the concept of "overfishing" can best be captured for species with high but variable M and high variance in recruitment (commonly referred to as "forage species"). Nonetheless, the conceptual basis for managing forage species with F reference points has many holes. These need to filled, or else a more appropriate framework for ensuring that overfishing is not occurring needs to be established. The groundwork was laid a decade ago at the 1996 Wakefield Symposium on Fisheries on Forage Species (Alaska Sea Grant Publication 1997), and this shrimp stock seems an ideal candidate for serious investigations. Such work should start soon, so that there is a complete and convincing biological basis for reference points used to prevent overfishing of forage species, before there is some crisis in management and science finds itself ill-equipped to provide support.

4. Evaluate current stock status with respect to the existing Biological Reference Points.

This Term of reference was addressed fully. Even if data from the 2007 fisheries and surveys were to indicate that the 2004 year-class would need to be revised downward substantially, the stock would be well above biomass reference points and its exploitation rate would be well below any reasonable F reference point. The future work discussed in 2 and 3 will be relevant to this ToR, when it needs to be revisited in the future.

5. Perform Sensitivity Analyses to determine the impact of uncertainty in the data on the assessment results.

The list of sensitivity analyses which are possible to undertake to explore the robustness of an assessment is almost infinitely long. Hence there is a sense in which such a ToR can never be completely discharged, and the evaluation should focus on whether the assessment team did a reasonable job of selecting the data sources and model parameters for sensitivity testing. In this case the choices were reasonable. This assessment explored sensitivity to mean weight of landed shrimp, incomplete reporting of catches in the terminal year, and natural mortality. The first two sources were found to have either very little effect on estimates of B and/or F, or effects exactly as expected from knowledge of the model structure - and effects that would have little impact on the management advice under current stock and fishery conditions.

Changes to the assumed value of natural mortality have predictable effects on estimates of B and F. With a model that appears to try to fit trends in landings and surveys, increases in M will rescale biomass and abundance upward to create the additional shrimp which die of natural mortality (presumably predation – see ToR 6), and rescale F downward because fishing becomes a smaller fraction of Z. This rescaling would have implications for appropriate B and F reference points, but relatively little impact on harvest advice within the rescaled framework, as long as biomass was healthy. There would be consequences for harvest advice when B was close to a biomass reference point appropriate for the higher M, and Z was expected to be high on the basis of M alone. This issue needs to be explored further as part of the follow-up to the results in ToR 6.

With regard to whether the assessment team chose the best parameters and data series on which to conduct sensitivity tests, the attention to landings (mean weight and terminal year landings) and M are both appropriate. The sensitivity to landings is important because the goodness of fit information indicated the CSA model tried hard to fit the patterns in landings, so errors in landings could be translated strongly into errors in estimates of B and F. The description of the fishery and presentation of the assessment team both expressed confidence that historic catch data are fairly reliable, but given the importance of the landings trend to model parameter estimation, that might be verified and documented clearly in future assessment reports. If there is cause to suspect historical landings data are not reliable, sensitivity of the model to underreporting of historical catches, as well as catches in the terminal years, would also be worth exploring. Although such inaccuracies in historical catch data might have little influence on

estimates of current year's B and F, were the model sensitive to such inaccuracies, it could affect estimates of reference points based on the patterns in B and F over time.

The summer survey index is also highly influential on the CSA estimates of B and F. Particularly in light of the additional investigations suggested in 2 and 3 with regard to using information on environmental covariates and spatial information in developing the annual survey indices of abundance, sensitivity analyses to the survey index would be informative. If the CSA estimates prove insensitive to modest variability introduced into the survey indices, than the priority given to improving those estimates would not be as high. However, if changing the pattern or absolute level of that index (or any of the survey indices) were to influence estimates of trends or the scale of B or F, then the work on those indices would be important.

6. Analyze food habits data and finfish biomass, to estimate biomass of shrimp consumed by major predators. Compare these results to current estimates of natural mortality used in the model.

The presentation at SARC 45 emphasised that the analyses of food habits, consumption rates, and biomasses of predators was still work in progress. The results regarding predation of *Pandalus* were the best available at the time, but further refinements could be expected. In that context progress on this ToR is excellent. The research on food and feeding relationships in the US waters of the northwest Atlantic is world class, and substantial progress has been made in consolidating the results for consumption of shrimp in the Gulf of Maine. There are remaining uncertainties in the estimates, some possibly introducing a negative bias to the estimates of consumption of *Pandalus* (not all predators included, possible overestimation of the catchability of predators in the surveys, lack of treatment of spatial overlap in the analyses) and some possibly introducing a positive bias in the estimates (possible predisposition to identify any shrimp-like food item as a *Pandalus*).

The team conducting these analyses have reasonable plans for reducing these uncertainties and expanding the scope of this work. The work they propose is scientifically sound, and they have shown excellence in the work completed to this point. Hence it is not considered necessary to give any specific guidance on exactly which tasks should be undertaken when, or how they should be done. It is a highly skilled team that understands the importance of the work remaining to be done. They should receive every encouragement to get on with it.

Notwithstanding the work remaining to be done on these estimates, the results justified a reconsideration of the natural mortality assumed in the assessment. The SARC 45 Summary Report discusses this issue, which should be one of the major priorities for the assessment team in the coming year. To support that work, the team members focusing on the *Pandalus* consumption estimates should review their computations, consider what improvements, if any, are necessary and feasible in the near future, and provide a set of consumption estimates that are considered "best possible given the information available" to the assessment team well in advance of the next assessment of this stock. The

assessment team will need those estimates to investigate a more appropriate value (or vector of time varying values) for M in the assessment, construct new stock histories given the revisions to M, explore the implications of the revised M for new biological reference points, and (depending on how M is revised) possibly develop appropriate ways to include M in forward projections of stock status under different harvesting regimes. These are all important tasks in improving the assessment framework of Gulf of Maine shrimp, and some may take some time to complete. Therefore it is important that these "best estimates" of consumption and associated mortality rate information be made available as early as possible.

7. Review, report, and evaluate status of research recommendations from the 2002 SARC working group.

This Term of Reference was met in full, in the sense that progress reports were made for each recommendation. However, as noted in the SARC 45 Summary Report, not all the past recommendations were discharged in full; on some little or no progress was made. Substantial progress was made on the recommendation to explore the natural mortality assumption, and the remaining work to consolidate progress should be a priority, much of it noted in ToR6 above. Of the remaining research recommendations from the 36th SAW, the one on which more progress would be particularly desirable is the recommendation to investigate survey selectivity. Many of the recommendations in ToR1 & ToR2 above would feed into this evaluation of selectivity, in the sense that in the current model formulation q is the parameter whereby factors affecting distribution, aggregation, or availability of shrimp to the survey would be conveyed into the model outputs. The degree to which q is size or time dependent needs to be understood and if not small, captured somehow in the assessment model. It is premature to speculate on the best way to have these effects enter the assessment, when the nature and magnitude of the effects have not yet been quantified, but this general area is a particularly high priority for improving future assessments. One of the creators of the Collie-Sissenwine Analysis (CSA) in fact confirmed that CSA could handle a dynamic q readily, so this work should contribute to direct improvements to the assessment.

<u>II – Review Biological Reference Points or their proxies, consider their adequacy, and if not adequate, propose alternatives.</u>

It was already a ToR for the assessment meeting to consider the Biological Reference Points for this stock. I concur with the conclusions in the SARC 45 Summary Report that at a minimum the biological reference points should be recalculated to apply to a population with an M higher than 0.25. However, as noted in the Summary Report and my own comments in I-ToR3 and I-ToR6, revision to M should be deferred until the work in progress on predator consumption and other aspects of natural mortality has been consolidated, and this work should be put on the fast track. If the work needed to review the survey series and past recruitment estimates in light of spatial processes and environmental covariates can also be brought to a point where consolidation is possible within a year or two, that work should be completed as well, prior to revising the Biological Reference Points. That would avoid frequently readjusting the values of the

reference points – an action that makes life difficult for managers and the industry and undermines confidence of others in the assessment framework.

As noted in the SARC 45 Summary Report, as long as stock size remains high due to very strong recruitment and exploitation rate remains low due to many factors including poor markets, there is very little risk to the stock posed by management based on the current reference points. Nor is it likely that in using the current reference points under current stock conditions, the fishery would be unnecessarily constrained from harvesting. However, the "current conditions" are unprecedented in the stock, and it is unwise to assume that they will persist in the medium term. In fact, downward revisions to the estimates of the size of the 2004 year-class are still possible, if the 2007 fishery and survey data suggest that survey q in recent years has been anomalously high. Hence the window of opportunity to complete the studies and analyses needed for the recalculation of reference points with the new information, while avoiding risk to the stock, the fishery, or both, is unlikely to be wider than one or two more assessment cycles. This strongly suggests that the priority given to Northern Shrimp by the state and federal science and assessment agencies overall should be raised for the next couple of years.

III – Report on statistical tests and analyses done by the reviewer.

No independent analyses were conducted for this assessment. I did a few simple statistical tests of recruitment patterns relative to stock size and environmental covariates for my own information, and as illustrations to a member of the assessment team, but they did not influence the current assessment. They did support the call that is made both in the SARC 45 Summary Report and part I of this review for more thorough investigation of these relationships, a call also supported by the assessment team itself. When that work is undertaken the data will be more complete and the analyses more appropriate than the few statistical tests I did to suggest that there are patterns warranting more thorough study.

IV – Any other points.

I have been able to address all my points of concern in the previous sections of this review. I have no outstanding questions that have not been raised above.

Atlantic Sea Scallops

I: Was each Term of Reference completed successfully and do the results provide a sound scientific basis for management advice?

1. Characterise the commercial fishery for Atlantic Sea Scallop.

This ToR was met satisfactorily. The information on the regulatory framework is valuable, and was presented both in narrative and as a figure, which was helpful. However, the figure is too noisy to make it really user friendly to those not already familiar with the fishery and its management. Perhaps focusing on displaying just information since 1994 would allow the figure to be more readily followed. Plotting the DAS data as histograms per type of fisher, and mapping the closed areas dynamically over time (they are presented on Fig B-7 by year, but visually that figure is dominated by the catch location data) might help.

The presentation of the fishery data can also be improved with regard to supporting the approach of analysing data for New England/Georges Bank (NEGB) separately from the mid-Atlantic area, before combining the analyses in the assessment. During the presentation the assessment team highlighted several times that a portion of the fleet will fish either of those two zones, depending on their expectations of catch rate in each area. This section would benefit from some way to document and report what fraction of the fleet practices that "switching" behaviour, how that fraction may have changed over time, and in particular (and probably most difficult) in a given fishing year what fraction of that fleet segment was in each area - and if switching occurs within season, how often it was happening. If there are concise ways to report that information, it would add greatly to understanding the dynamic aspect of the catch information (landings, effort, discards, LPUE, etc). Without this information there will always be some ambiguity in interpreting trends in catch and effort information. This ambiguity will become more concerning if the assessment approach develops to use spatial information (see the next section).

I also note that some of the information on discard and non-capture mortality is quite old (Caddy 1973, Murawski and Sherchuk 1989). Unless fishing and handling procedures have been exceptionally traditional over time, consideration should be given to repeating some of these studies under current fishing practices, and update these values in the assessment.

2. Estimate fishing mortality and exploitable stock biomass, characterise uncertainty in the estimates, and provide estimates for earlier years.

This ToR was addressed fully. The evidence for the recent marked increase in stock biomass is convincing, as is the evidence for the decline in F for the whole stock and the mid-Atlantic portion.

The CASA model is appropriate for this stock. The fact that for individual scallops growth increments can only be estimated accurately for a few annual rings back from the most recent limits the choices of assessment models to some extent, and CASA makes effective use of the indices from the several scallop surveys that are conducted. The bootstrapped confidence intervals around the abundance estimates from the NEFSC (fig B5-3 in the assessment document) are useful in capturing the uncertainty in this index of population status, but it is unclear how that uncertainty was brought into the later estimates of stock biomass and fishing mortality. The description of the analytical methods spends some time on the important dredge efficiency issue, including presenting options for estimating status and trends that do not require a parameter(s) that converts the survey information into absolute biomass values. Similar attention to how the uncertainty in the survey estimates was carried into the subsequent assessment is also warranted. The likelihood profile information, although voluminous to have to work through, gave a good basis for evaluating the support that the various indices provide for the final assessment of status and trends in B and F.

The modest recent retrospective pattern in the separate analyses of the NEGB and mid Atlantic units is of some concern. It is convenient that the two patterns are reciprocal, so they largely cancel each other out in the combined analyses. However, one needs to keep in mind that two wrongs don't necessarily make a right. It is easy to imagine scenarios that could produce a causal link between the two patterns, such that the biological or fishery process causing a positive (say) pattern in one unit would necessarily cause a negative pattern in the other, and their cancellation at the scale of the whole area would be biologically reasonable. If any such scenario is the actual case, then, although efforts should still be made to reduce the retrospective pattern, ones of the modest size apparent here are not a cause for much concern. However, until there is adequate understanding of *why* the patterns seem reciprocal in both scale and time, it could also be that we are just lucky in having them appear to cancel. We cannot count on staying lucky forever.
The other CIE reviewers will comment in greater detail on aspects of the CASA model. My greatest concern with this assessment is that there is a great deal of spatial information in the survey catches, much of which is lost when the survey indices are calculated. The existing stratification scheme does retain some of the spatial information, but it seems that even the stratification system needs to be fiddled with every time there are changes to the areas that are opened or closed. Scallop populations were among the early case histories for the application of geostatistical methods to biological populations (Ecker, M.D., and Heltshe, J.F. 1994. "Geostatistical estimates of Scallop Abundance", In, Case Studies in Biometry, Lange et al., editors. Wiley, New York), and although I am not a fan of kriging for marine populations, many alternatives exist that are not as prone to underestimate uncertainty (see references in section I-ToR2 of Shrimp). These might lead to survey based indices that track population trends as well or better than the current indices do. They may or may not have a lower variance than the current indices, but whatever their uncertainty, it will be more realistically reflected in estimates that take more complete account of the spatial relationships of the survey catches. The spatial methods would also allow more direct investigations of management options that include spatial measures such as fixed or rotating closures.

There are several reasons to want to increase the degree to which the assessment computations capture the spatial information in the surveys. It is clear that spatial tools are likely to remain important to the management of this resource, and the effects of management and fishing leave a spatial record that is relevant to evaluating current status of the resource and consequences of future management options. The spatial pattern of scallops also seems important to the pattern of fishery operations. Habitat affinities and biological processes associated with dispersal and recruitment also are likely to lead to spatial pattern that can be informative. All of these are reasons to try to take advantage of the spatial information that is present in the survey when assessing stock status, and to the extent possible include more spatial information in the advice provided to managers.
In the process of conducting the spatial analyses, it would of course be worthwhile to consider covariates to "space" such as depth, substrate type, up-current or down-current, and possibly environmental features such as temperature. From their presentation and discussions it appears that the assessment team has a good grasp of the covariates likely to be most worthy of attention, and good mastery of the analytical methods needed for the investigation. Looking at how these covariates affect abundance, distribution, and productivity of scallops should not be a replacement for the spatial analyses recommended above, but could be good complements to that work.

3. Comment on the scientific adequacy of the biological reference points.

This ToR was addressed adequately. The SARC 45 Summary Report has some important points about the biological reference points, which warrant careful attention. I concur that the evidence for an increase in the F reference point from 0.24 to 0.29 is strong enough to justify making the change in the short term, even if there are further analyses that could be done. It is also important to note that biomass reference point of 5.6 kg/tow is specific to a particular survey conducted and analysed in a particular way. Any substantial change to the survey or to the method of analyses (including the types of spatial analyses I suggest above) would require rescaling the biomass reference points to have the same *relative* position on the new survey index. The assessment team is well aware of this need, but the explanation of the rescaling is quite technical, and I expect it would be hard to follow for many lacking a strong analytical background. When the reasons for and methods of adjusting reference points are not transparent to managers and fishers, scientifically sound adjustments to reference points can look like just fiddling with numbers to many whose lives are affected by the changes. Developing reference points which are either inherently relative (presented as a position on a scale, not as a value that has an absolute meaning - like kg/tow) or robust to sampling method often increase the confidence of others in the rule-based management.

The assessment team is well aware of the shortcomings in yield per recruit analyses as a starting point for estimating biological reference points. The fitted curve rose steeply and asymptoted early to gave a very flat surface on which to define reference points. This is a weak basis for developing reference points based on the usual productivity (stock-recruit) rationales, and the assessment team's choice of F*max* and B*max* as proxies is wiser than trying to use such poorly defined msy positions as a basis for selecting reference points.

I am not particularly enthusiastic about the situation, however, and would consider it a priority to solidify the scientific basis for these – or any other – biological reference points. The stock recruit plots that were provided at our request do appear to have the majority of observations clustered in a cloud of points. The fitted curve just skims above this cloud of points, with most the remaining points scattered in a looser column directly above that cloud (same range on the x-axis). Only six years of S-R pairs lie at SSBs (egg potentials) higher than that narrow cloud on the x-axis, so it is possible that no model-based analyses of the data will provide any greater insight into how productivity of the stock varies with stock condition. However, the types of probabilistic methods suggested in the shrimp review might provide some greater information here as well. This point is also developed further in the SARC 45 Summary Report.

There is a second issue to do with reference points for this stock that is more urgent, however. With spatial management tools being used regularly (possibly increasingly) in this stock, both the science and the management community need to get a clear and shared understanding of exactly what population it is to which these reference points apply. If there are closed areas where F really is essentially zero, and the biomass only suffers natural mortality, is management best guided by single B and F reference points that are intended to apply to the whole stock? If yes, should the values of the reference points be independent of how large and where the closed areas are, and how long they are likely to remain closed? If no, where should guidance be found?

Experts differ in their views on this point, and little of the debate has yet made it into the scientific literature (but see, for example, Investigation of closed-area management of North Sea cod – 2005 DEFRA Report Defra-SFCD15). However, this scallop population seems an ideal candidate for serious investigation of biomass and fishing mortality reference points appropriate to a population with rotating spatial management, probably relying heavily on simulation approaches. The assessment team has the necessary analytical skills, the stock is comparatively data rich with regard to both survey and fisheries data, productivity dynamics of the stock are comparatively well understood, spatial openings and closings are likely to remain important tools for management, and the stock and recruit and yield-per-recruit patterns provide at best a weak basis for estimating conventional F and B reference points.

5. Recommend modelling approaches and data to use for conducting projections and computing TACs or TALs.

This ToR was fully discharged. The SAMS model is an analytically sound and biological reasonable tool for making one-year and multi-year projections. The inclusion of spatial dynamics for the fishery, and to a lesser extent for the growth components of the projection model, are important features of the model that make it useful in scenario exploration of management options for sea scallop. Both seem to be modelled in reasonable ways in SAMS. The flexibility in the spatial components of SAMS is a particularly valuable feature, because the places and times of openings and closings seem to reflect more a process of consultation/negotiation between the managers and industry, informed “on the go” by the available science, than a process based on a firm long-term

plan with a pre-determined (science based?) schedule or rules. As long as management wishes to retain this flexibility in how spatial management is implemented, the spatial features of SAMS will be necessary in projections made as part of exploring consequences of management options.

The SARC 45 Summary Report includes some observations and proposals for improving the recruitment component of SAMS. I concur strongly with these observations. For very short term projections (1-2 years), the recruitment component of SAMS (or any other) projection model ought not be a major issue, because if the resource is being exploited sustainably with an F in the neighbourhood of the target, then most harvest should be of ages/sizes that are well quantified in surveys and the assessment. However, if the projections are done to explore the consequences of multi-year closures or other medium or longer term options, then it will be important to have a recruitment module in the projection model that is scientifically sound. All the evidence points to recruitment having some multiyear pattern, even if it is not yet clear if this is driven by environmental forcers that have multi-year inertia, by multi-year trends in spawner potential, or some combination of factors. Whatever the cause of the apparent temporal autocorrelation in recruitment, if SAMS (or any other projection model) is going to be used for multiyear projections, then improving the realism of the recruitment module should be a priority for research and analysis. The assessment team has some clear and sound ideas for undertaking such investigations, and comments made in several other parts of this review and the SARC 45 Summary Report might be helpful in developing a research plan for this important work.

6. If possible, undertake 2-3 year projections of biomass and fishing mortality under different management scenarios, and characterise the uncertainty of the possible trajectories.

This ToR was discharged fully. The SAMS model was used to make projections under two levels of F, and with assumptions about the continuation of current spatial closures and some changes in areas open and closed. The projections included stochastic variation in most of the expected parameters, such that uncertainty in trajectories of B, F and catches were represented. The inclusion of a suggestion from the Review Panel to include some individual trajectories in the projections, as well as confidence intervals around the suite of projections for each scenario help clarify further to managers and industry the range of outcomes possible were any of the management options to be adopted. Given that the projections extrapolate forward from the currently assessed state of the resource, the outcomes of all the projections were dominated by the presence of strong incoming recruitment to the stock. Variation among the scenarios was largely in the rate of increase in landings and biomass, as the magnitude and distribution of F was varied.

It is noted that in all scenarios, “fishing mortality in each area was assumed to be proportional to fishable biomass” (draft assessment report, page 31). Discussion during the presentation of the assessment about the mobility of at least a portion of the fleet to switch fishing areas as a function of expected yields suggests that this does happen to

some extent, but I did not have the impression that the question had been investigated thoroughly. This strategy hardly seems the only possible way that the fleet could choose to distribute effort, and I would encourage in the future that other possibilities be explored as well. As a complement to exploring more diverse scenarios, the VMS information, LPUE data, and other data sources from the fishery can be combined with the spatial information in the survey, to investigate how the fleet actually does allocate its effort relative to resource status. These analyses would give greater importance to some of the other investigations I propose earlier in the review, with regard to reporting on the dynamics of fleet options (section 1) and spatial analyses of the resource and fishing patterns (Sections 2 and 3). Even if no other benefits accrued, the combination of modelling and data analyses might identify combinations of stock status (spatial pattern of abundance as well as total fishable biomass) and fishing strategies where specific management strategies might not be effective at keeping risk to the stock low.

7. Review progress on research recommendations.

As noted in the SARC 45 Summary Report, progress on past research recommendations was excellent. Some of the recommendations most important for ensuring the reliability of the assessment have been completed, such as #1 and 4 (calibrating gears and quantifying selectivity in the industry and surveys), #5 and 6 (better quantification and understanding of patterns of growth and shell height-weight relationships), and particularly #8 (evaluating the performance of CASA as the core assessment method). There remains further work to do on some of the recommendation, but even in these cases substantial initiative has been shown. For example, in addressing recommendation #3 (explore use of VMS and landings data to provide information on stock status on grounds that cannot be surveyed), the team has taken advantage of new opportunities presented by the increasing availability of video survey methods, to go beyond the initial focus of the recommendation on commercial data sources.

I have no additional suggestions with regard to progress on the previous research recommendations. My concerns and priorities for new research are reflected fully in the section of the SARC 45 Summary Report on research recommendations.

<u>II – Review Biological Reference Points or their proxies, consider their adequacy, and if not adequate, propose alternatives.</u>

There was a specific ToR for the meeting to review biological reference points and update them as needed. The text in I-ToR3 of this sea scallop review contains my views on the proposed change in the F reference point (which I support), and my thoughts on the remaining work to be done to improve the scientific basis for reference points for both biomass and fishing mortality. As stated in the SARC 45 Summary Report, I concur that the revised reference points will be a sound basis for management of sea scallop, and under current conditions will keep risk to the stock very low. However, as described in both the SARC 45 Summary Report and my comments in I-ToR3, more work is needed to ensure that the biological reference points are the best possible to use in a stock where the exploitable resource is largely sedentary, the fishery is highly mobile, and spatial

management tools are central to management. This work should be a high priority for the near future.

III – Report on statistical tests and analyses done by the reviewer.

No independent analyses were conducted for this assessment. I discussed with the assessment team some analytical methods that co-workers and I have developed for spatial analyses of survey data, and for estimating reference points when there is no evidence of an overall stock recruitment relationship. However, I did not have the necessary software with me to apply those methods, and even if I had, the applications would have been illustrative and not for inclusion in the 2007 assessment and advice. The assessment team has the references to the suggested methods and will be exploring them as part of their continuing work.

IV – Any other points.

I have been able to address all my points of concern in the previous sections of this review. I have no outstanding questions that have not been raised above in this report.

Appendix 1: Background material

ASFMC Northern Shrimp Technical Committee. 2004. Amendment 1 to Interstate Fishery Management Plan for Northern Shrimp.

ASFMC Northern Shrimp Technical Committee, Spear, B., and J. Link. 2007. Assessment Report for Gulf of Maine Northern Shrimp.

Hart, D. R. 2006. Sea Scallop Stock Assessment Update for 2005. Woods Hole, MA: NEFSC/NMFS/NOAA/DOC.

Hart, D. R. 2003. Yield- and biomass-per-recruit analysis for rotational fisheries, with an application to the Atlantic sea scallop (*Placopecten magellanicus*). *Fisheries Bulletin* 101: 44-57.

Hart, D. R. 2001. Individual-based yield-per-recruit analysis, with an application to the Atlantic sea scallop, *Placopecten magellanicus. Canadian Journal of Fisheries and Aquatic Sciences* 58: 2351-2358.

Hart, D. R., and P. J. Rago. 2006. Long-Term Dynamics of U.S. Atlantic Sea Scallop *Placopecten magellanicus* Populations. *North American Journal of Fisheries Management* 26: 490-501.

McInnes, D. 1986. Interstate Fishery Management Plan for the Northern Shrimp (*Pandalus borealis kroyer*) fishery in the western Gulf of Maine.

Northern Shrimp Assessment Summary Report for 2007.

SARC 36 Northern Shrimp Advisory Report.

SARC 36 Northern Shrimp Consensus Summary.

SAW Invertebrate Subcommittee. 2007. Stock Assessment for Atlantic Sea Scallops (*Placopecten magellanicus*): Consensus Assessment Report, SARC 45 draft.

SAW Invertebrate Subcommittee. 2004. Stock Assessment for Atlantic Sea Scallops (*Placopecten magellanicus*): Consensus Assessment Report, SARC 39. Woods Hole, MA: NEFSC/NMFS/NOAA/DOC.

Stokesbury, K. D. E., Harris, B. P., Marino, M. C., and J. I. Nogueira. 2004. Estimation of sea scallop abundance using a video survey in off-shore US waters. *Journal of Shellfish Research* 23 (1): 33-40.

Appendix 2: Statement of Work

Consulting Agreement between the University of Miami and Dr. Jake Rice

Statement of Work

May 2, 2007

General

The Northeast Regional Stock Assessment Review Committee (SARC) meeting is a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review tabled stock assessments and models. The SARC is the cornerstone of the Northeast Stock Assessment Workshop (SAW) process, which includes assessment development (SAW Working Groups or ASMFC technical committees), assessment peer review, public presentations, and document publication.

The SARC 45 review panel will be composed of three appointed reviewers from the Center of Independent Experts (CIE), and a chair from the Scientific and Statistical Committee (SSC) of the regional Fishery Management Councils. The panel will convene at the Woods Hole Laboratory of the Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts, from June 4-9, 2007 to review two assessments (Atlantic sea scallop, *Placopecten magellanicus*; Northern shrimp, *Pandalus borealis*). In the days following the review of the assessments, the panel will write the SARC Summary Report and each CIE reviewer will write an individual independent review report.

Specific Activities and Responsibilities

The CIE's deliverables shall be provided according to the schedule of milestones listed on Page 5. The CIE reviewers, along with input from the SARC Chairman, will write the SARC Summary Report. In addition, each CIE reviewer will write an individual independent review report. These reports will provide peer-review information for a presentation to be made by NOAA Fisheries at meetings of the New England and Mid-Atlantic Fishery Management Councils in 2007. The SARC Summary Report shall be an accurate and fair representation of the SARC panel viewpoint on how well each SAW Term of Reference was completed (please refer to Annex 1 for the SAW Terms of Reference).

The three SARC CIE reviewers' duties shall occupy a maximum of 14 days per person (i.e., several days prior to the meeting for document review; the SARC meeting in Woods Hole; and several days following the open meeting to contribute to the SARC Summary Report and to produce the Independent CIE Reports).

The SARC chair's duties shall occupy a maximum of 17 days (i.e., several days prior to the meeting for document review; the SARC meeting in Woods Hole; several days following the open meeting for SARC Summary Report preparation.)

Charge to SARC panel

The panel is to determine and write down whether each Term of Reference of the SAW (see Annex 1) was or was not completed successfully during the SARC meeting. To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. Where possible, the chair shall identify or facilitate agreement among the reviewers for each Term of Reference of the SAW.

If the panel rejects any of the current Biological Reference Point (BRP) proxies for B_{MSY} and F_{MSY}, the panel should explain why those particular proxies are not suitable and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing BRPs are the best available at this time.

Roles and responsibilities

(1) Prior to the meeting

(SARC chair and CIE reviewers)

Review the reports produced by the Working Groups and read background reports.

(2) During the Open meeting

(SARC chair)

Act as chairperson, where duties include control of the meeting, coordination of presentations and discussion, making sure all Terms of Reference of the SAW are reviewed, control of document flow, and facilitation of discussion. For each assessment, review both the Assessment Report and the Assessment Summary Report.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to discuss the stock assessment and to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

(SARC CIE reviewers)

For each stock assessment, participate as a peer reviewer in panel discussions on assessment validity, results, recommendations, and conclusions. From a reviewer's point of view, determine whether each Term of Reference of the SAW was completed successfully. Terms of Reference that are completed successfully are likely to serve as a basis for providing scientific advice to management. If a reviewer considers any

existing Biological Reference Point proxy to be inappropriate, the reviewer should try to recommend an alternative, should one exist.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

(3) After the Open meeting

(SARC CIE reviewers)

Each reviewer shall prepare an Independent CIE Report (see Annex 2). This report should explain whether each Term of Reference of the SAW was or was not completed successfully during the SARC meeting, using the criteria specified above in the "Charge to SARC panel" statement.

If any existing Biological Reference Point (BRP) proxies are considered inappropriate, the Independent CIE Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRPs are the best available at this time.

During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments may be raised. Comments on these questions should be included in a separate section at the end of the Independent CIE Report produced by each reviewer.

If a reviewer feels that his/her comments are adequately expressed in the SARC Summary Report, it will not be necessary to repeat the same comments in the Independent CIE Report. In that case, the Independent CIE Report can be used to provide greater detail on specific Terms of Reference or additional questions raised during the meeting.

(SARC chair)

The SARC chair shall prepare a document summarizing the background of the work to be conducted as part of the SARC process and summarizing whether the process was adequate to complete the Terms of Reference of the SAW. If appropriate, the chair will include suggestions on how to improve the process. This document will constitute the introduction to the SARC Summary Report.

(SARC chair and CIE reviewers)

The SARC Chair and CIE reviewers will prepare the SARC Summary Report. Each CIE reviewer and the chair will discuss whether they hold similar views on each Term of Reference and whether their opinions can be summarized into a single conclusion for all or only for some of the Terms of Reference of the SAW. For terms where a similar or a consensual view can be reached, the SARC Summary Report will contain a summary of such opinions. In cases where multiple and/or differing views

exist on a given Term of Reference, the SARC Summary Report will note that there is no agreement and will specify - in a summary manner – what the different opinions are and the reason(s) for the difference in opinions.

The chair's objective during this Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the panel to reach an agreement if it cannot reach one. The chair will take the lead in editing and completing this report. The chair may express the chair's opinion on each Term of Reference of the SAW, either as part of the group opinion, or as a separate minority opinion.

The SARC Summary Report (please see Annex 3 for information on contents) should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, this report should state why that Term of Reference was or was not completed successfully.

If any existing Biological Reference Point (BRP) proxies are considered inappropriate, the SARC Summary Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRP proxies are the best available at this time.

The contents of the draft SARC Summary Report will be approved by the CIE reviewers by the end of the SARC Summary Report development process. The SARC chair will complete all final editorial and formatting changes prior to approval of the contents of the draft SARC Summary Report by the CIE reviewers. The SARC chair will then submit the approved SARC Summary Report to the NEFSC contact (i.e., SAW Chairman).

Schedule

The milestones and schedule are summarized in the table below. No later than June 22, 2007, the CIE reviewers should submit their Independent CIE Reports to the CIE for review[1]. The Independent Reports shall be addressed to "University of Miami Independent System for Peer Review," and sent to Dr. David Sampson, via e-mail to David.Sampson@oregonstate.edu and to Mr. Manoj Shivlani via e-mail to mshivlani@rsmas.miami.edu

[1] All reports will undergo an internal CIE review before they are considered final.

Milestone	Date
Open workshop at Northeast Fisheries Science Center (NEFSC) (begin writing reports, as soon as open Workshop ends)	June 4-7, 2007
SARC Chair and CIE reviewers work at the NEFSC drafting reports	June 7- 9
Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair **	June 22
CIE reviewers submit Independent CIE Reports to CIE for approval	June 22
SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman)	June 29
CIE provides reviewed Independent CIE Reports to NMFS COTR for approval	July 6
COTR notifies CIE of approval of reviewed Independent CIE Reports	July 13 *
COTR provides final Independent CIE Reports to NEFSC contact	July 13

* Assuming no revisions are required of the reports.

** The SARC Summary Report will not be submitted, reviewed, or approved by the CIE.

The SAW Chairman will assist the SARC chair prior to, during, and after the meeting in ensuring that documents are distributed in a timely fashion.

NEFSC staff and the SAW Chairman will make the final SARC Summary Report available to the public. Staff and the SAW Chairman will also be responsible for production and publication of the collective Working Group papers, which will serve as a SAW Assessment Report.

NEFSC Contact person and SAW Chairman:
Dr. James R. Weinberg, NEFSC, Woods Hole, MA. 508-495-2352,
James.Weinberg@noaa.gov

Submission and Acceptance of CIE Reports

The CIE shall provide via e-mail the final Independent CIE Reports in pdf format to Dr. Lisa Desfosse (Lisa.Desfosse@noaa.gov) for review by NOAA Fisheries and approval by the COTR, Dr. Stephen K. Brown, by July 6, 2007. The COTR shall notify the CIE via e-mail regarding acceptance of the reports by July 13, 2007. The COTR will transmit the Independent CIE Reports to the NEFSC contact no later than July 13, 2007.

ANNEX 1:
Terms of Reference for the 45th Northeast Regional Stock Assessment Workshop

(Revised March 7, 2007)

A. Sea Scallops

1. Characterize the commercial catch, effort and CPUE, including descriptions of landings and discards of that species.

2. Estimate fishing mortality, spawning stock biomass, and total stock biomass for the current year and characterize the uncertainty of those estimates. If possible, also include estimates for earlier years.

3. Either update or redefine biological reference points (BRPs; proxies for B_{MSY} and F_{MSY}), as appropriate. Comment on the scientific adequacy of existing and redefined BRPs.

4. Evaluate current stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 3).

5. Recommend what modeling approaches and data should be used for conducting single and multi-year stock projections, and for computing TACs or TALs.

6. If possible,

    a. provide numerical examples of short term projections (2-3 years) of biomass and fishing mortality rate, and characterize their uncertainty, under various TAC/F strategies and

    b. compare projected stock status to existing rebuilding or recovery schedules, as appropriate.

7. Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in recent SARC reviewed assessments.

B. Northern Shrimp

1. Characterize the Gulf of Maine northern shrimp commercial catch, effort, and CPUE, including descriptions of landings and discards of that species.

2. Estimate fishing mortality and exploitable stock biomass in 2006 and characterize the uncertainty of those estimates. Also include estimates for earlier years.

3. Comment on the scientific adequacy of existing biological reference points (BRPs).

4. Evaluate current stock status with respect to the existing BRPs.

5. Perform sensitivity analyses to determine the impact of uncertainty in the data on the assessment results.

6. Analyze food habits data and existing estimates of finfish stock biomass to estimate annual biomass of northern shrimp consumed by cod and other major predators. Compare consumption estimates with removals implied by currently assumed measures of natural mortality for shrimp.

7. Review, evaluate and report on the status of the 2002 SARC/Working Group Research Recommendations.

ANNEX 2: Contents of SARC CIE Independent Reports

1.

For each assessment reviewed, the report should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, state why that Term of Reference was or was not completed successfully. To make this determination, CIE reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice. Scientific criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable.

If a reviewer feels that his/her comments are adequately expressed in the SARC Summary Report, it will not be necessary to repeat the same comments in the Independent CIE Report. In that case, the Independent CIE Report can be used to provide greater detail on specific Terms of Reference or additional questions raised during the meeting.

2.

If any existing Biological Reference Point (BRPs) proxies are considered inappropriate, include recommendations and justification for alternative proxies. If such alternatives cannot be identified, then indicate that the existing BRPs are the best available at this time.

3.

Any independent analyses conducted by the CIE reviewers as part of their responsibilities under this agreement should be incorporated into their Independent CIE Reports. It would also be helpful if the details of those analyses (e.g, computer programs, spreadsheets etc.) were made available to the respective assessment scientists.

4.

Additional questions that were not in the Terms of Reference but that are directly related to the assessments. This section should only be included if additional questions were raised during the SARC meeting.

ANNEX 3: Contents of SARC Summary Report

1.

The main body of the report shall consist of an introduction prepared by the SARC chair that will include the background, a review of activities and comments on the appropriateness of the process in reaching the goals of the SARC. Following the introduction, for each assessment reviewed, the report should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, the SARC Summary Report should state why that Term of Reference was or was not completed successfully.

To make this determination, the SARC chair and CIE reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice. Scientific criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. If the CIE reviewers and SARC chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

2.

If any existing Biological Reference Point (BRP) proxies are considered inappropriate, include recommendations and justification for alternative proxies. If such alternatives cannot be identified, then indicate that the existing BRPs are the best available at this time.

3.

The report shall also include the bibliography of all materials provided during SAW 45, and any papers cited in the SARC Summary Report, along with a copy of the CIE Statement of Work.

The report shall also include as a separate appendix the Terms of Reference used for SAW 45, including any changes to the Terms of Reference or specific topics/issues directly related to the assessments and requiring Panel advice.